[0014] Another device uses a specially designed stylus, see U.S. Pat. No. 6,938,221, "User Interface for Stylus-Based User Input," issued to Nguyen on Aug. 30, 2005; and U.S. Pat. No. 6,791,536, "Simulating Gestures of a Pointing Device using a Stylus and Providing Feedback Thereto," issued to Keely et al. on Sep. 14, 2004. That device can detect 'hovering,' i.e., when the stylus is near the surface but not actually in contact with the surface. If the stylus is hovering, then the cursor is simply moved, i.e., positioned, and if the pen is in contact with the surface, then the cursor is dragged, i.e., engaged.

[0015] Right clicking is supported by holding a button on the stylus, by bringing the stylus in contact with the surface for an extended moment, or by selecting a 'right click' displayed menu icon to indicate that the next touch should be interpreted as a right click. It is the lack of the hovering state, as opposed to two others states of touching or not touching, which makes emulating both mouse positioning and engagement modes so difficult on most touch surfaces. In most cases, such devices support only one of the modes—either positioning or engagement, with no smooth transition between the two.

[0016] It is desired to emulate a mouse by touching a multi-touch sensitive display surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. **1** is a schematic of a user interface using a multi-touch sensitive display surface according to an embodiment of the invention;

[0018] FIGS. **2**A-**2**C are schematics of using multiple fingers on one hand to position a cursor according to an embodiment of the invention;

[0019] FIG. **3** is a schematic of using multiple fingers to switch between cursor modes according to an embodiment of the invention;

[0020] FIG. **4** is a schematic of using multiple fingers to drag a cursor according to an embodiment of the invention;

[0021] FIG. **5** is a schematic of using multiple fingers on two hands to position a cursor according to an embodiment of the invention;

[0022] FIG. **6** is a state diagram of principle states for emulating clicking or dragging with the left mouse button engaged on a multi-touch sensitive surface according to one embodiment of the invention;

[0023] FIG. **7** is a state diagram of principle states for emulating clicking or dragging with the right mouse button engaged on a multi-touch sensitive surface according to one embodiment of the invention;

[0024] FIG. **8** is a state diagram of principle states for emulating clicking or dragging with the middle mouse button engaged on a multi-touch sensitive surface according to one embodiment of the invention;

[0025] FIG. **9** is a state diagram of principle states for emulating repositioning the mouse cursor with no mouse buttons engaged, and for emulating toggling the activation of the left mouse button on a multi-touch sensitive surface according to one embodiment of the invention; and

[0026] FIG. **10** is a state diagram of principle states for emulating rotating a mouse wheel up or down on a multi-touch sensitive surface according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] The embodiments of the invention emulate mouse-like control with a multi-touch sensitive display surface. As defined herein, position and positioning apply to a displayed cursor, and location and locating apply to touches on the surface. That is, the positioning is virtual and relates to displaying a cursor or other graphic objects in an image displayed on the surface. The locating is physical, and relates to the physical sensing of contacts by fingers or the whole hand. Note that the methods as described herein are applicable to any multi-touch touch-sensitive device. Our preferred embodiment uses the touch surface as a table, but an orientation of the surface could be any, e.g., wall, table, angled-surface.

[0028] FIG. **1** shows an example multi-modal, multi-touch sensitive graphic user interface **100** according to the embodiments of our invention. The example system includes a table **110** electrically connected to a multi-touch sensitive display surface **200**, chairs **120**, a projector **130**, and a processor **140**. When a user sitting in one of the chairs touches one or more locations on the display surface **200**, a capacitive coupling occurs between the user and the locations touched on the surface. The locations are sensed by the processor and operations are performed according to the touched locations.

[0029] It is desired to emulate a hand operated 'mouse' by touching the surface directly, for example with one or more fingers, one or two hands, a fist and the like. It should be noted that the actions taken by the computer system depend on the underlying application programs that respond to the mouse events generated by the touching.

[0030] Multiple touches or gestures can be sensed concurrently for a single user or multiple users. It is also possible to identify particular users with the touches, even while multiple users touch the surface concurrently. Images are displayed on the surface by the projector **130** according to the touches as processed by the processor **140**. The images include sets of graphic objects. A particular set can include one or more objects. The displayed objects can be items such as text, data, images, menus, icons, and pop-up items. In our preferred embodiment the touch-surface is front-projected; the display technology is independent of our interaction techniques. Our techniques can be used with any multi-touch touch-sensitive surface regardless of how the images are displayed.

[0031] We prefer to use a direct-touch display surface that is capable of sensing multiple locations touched concurrently by multiple users, see Dietz et al., "DiamondTouch: A multi-user touch technology," Proc. User Interface Software and Technology (UIST) 2001, pp. 219-226, 2001, and U.S. Pat. No. 6,498,590 "Multi-user touch surface, issued to Dietz et al., on Dec. 24, 2002, incorporated herein by reference. Hand gestures are described in U.S. patent application Ser. No. 10/659,180, "Hand Gesture Interaction with Touch Surface," filed by Wu et al., on Sep. 10, 2003, incorporated herein by reference.